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(54) **Indicating device, especially for indicating the state of pressure of a tyre.**

(57) The invention relates to an indicating device, especially for indicating the state of pressure of a tyre, of the type that can be fixed to a wheel and comprises means (7) for measuring the pressure of the type (2); a transducer/transmitter (8) which converts the measured magnitude of the pressure into an electrical signal and transmits said electrical signal to an electronic unit; and a source of electrical power (12, 13) for the transducer/transmitter (8). In order to make the device not only more practical and operationally reliable but also less expensive, the invention provides an electrical power source consisting of an inductive current generator formed by a rotor (12) which is fixed coaxially to the wheel so as to rotate as one piece therewith, and by a coaxial stator (13) which is freely rotatable with respect to the rotor (12) and is provided with a counterweight (14) capable of keeping the stator (13) essential-ly motionless with respect to the rotor (12) as the rotor rotates with the wheel.

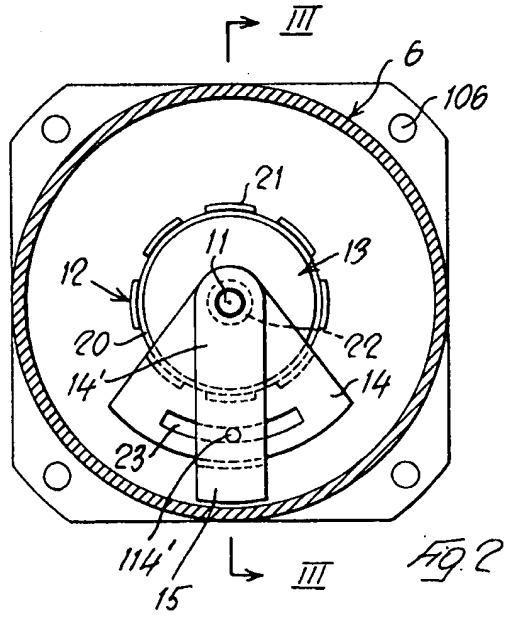

Fig 2

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The invention relates to an indicating device, especially for indicating the state of pressure of a tyre, of the type that can be fixed to a wheel and comprises means for measuring the pressure of the tyre; a transducer/transmitter which converts the measured magnitude of the pressure into a corresponding electrical signal and transmits said signal to an electronic unit; and a source of electrical power for the transducer/transmitter.

In these kinds of indicators, one of the main problems is where the electrical power supply should be located. Since the indicators are mounted directly on the wheel, that is on a revolving part, the use of those sources of electrical energy attached to the vehicle involves an increased expenditure in terms of construction and maintenance and high production costs.

It is the object of the invention to provide an indicating device, especially for indicating the state of pressure of a tyre of the type described at the beginning, whose power source must be extremely reliable, structurally simple and robust, occupying very little space and costing as little as possible.

The invention achieves the above objects in the form of an indicating device especially for indicating the state of pressure of a tyre, whose electrical power source consists of an inductive current generator formed by a rotor which is fixed coaxially to the wheel rotatably therewith and by a coaxial stator which is freely rotatable with respect to the rotor and is provided with at least one counterweight capable of keeping the stator essentially motionless with respect to the rotor and of overcoming the magnetic forces of attraction between the stator and the rotor as the rotor rotates with the wheel.

In a further improvement, in order to prevent the counterweight from swinging, for example during acceleration and deceleration, the counterweight is connected dynamically to damping means which damp said swinging movements, that is means for dissipating the accumulated kinetic energy.

Advantageously, the winding in which the electrical current is induced is part of the rotor and is fixed coaxially to the wheel so as to describe no relative movement with respect thereto, while the stator consists of a permanent, especially a multipolar, magnetic part.

The advantages of the invention are obvious from the above. By using the kinetic energy of rotation of the wheel and the force of gravity and inertia to generate electrical current, a source of electrical power for the indicating device has been provided which avoids all the problems relating to the construction of electrical contacts between relatively revolving parts and whose life is not limited in time. This problem has been eliminated with regard also to the generator itself since the induction coils are attached to the rotor and revolve with the wheel, whereas it is the stator, which is formed by the permanent magnetic part, that forms a relative rotary movement with respect to the wheel. The parts in relative movement are only the supports of the spindle of the stator which can easily and economically be made sufficiently robust and durable. The means for damping the swinging motion of the counterweight prevent the appearance of secondary effects which can lead either to a drastic reduction in the amount of electrical energy produced or to the complete prevention of its generation, because if there were no such means provided, the swinging motion could lead to a reduction in the inertial rest state of the counterweight owing to the progressive accumulation of kinetic energy. This could bring about a dynamic coupling between the wheel and the counterweight so that the counterweight and the stator begin to rotate with the rotor and with the wheel. The indicating device is easy and cheap to produce and occupies very little space.

The invention also relates to other features which further improve the indicating device set out above and which are the subject of the subsidiary claims.

The particular features of the invention and the advantages procured thereby will be explained in greater detail in the description of a preferred embodiment, which is illustrated by way of a non-restricting example in the accompanying drawings in which:

Fig. 1 is a diagrammatic perspective view of a wheel fitted with the indicating device for indicating the state of pressure of the tyre according to the invention.

Fig. 2 shows a diagrammatic front elevation of the device shown in Fig. 1, with the box open.

Fig. 3 shows an enlarged section taken through the line III-III seen in Fig. 2.

Fig. 4 is a view similar to Fig. 1 of a variant of the device according to the invention which may be fitted to a rim cover or to a hubcap of the type that is fixed coaxially to the rim itself.

Fig. 5 shows a cross section of the device shown in Fig. 4 mounted on a rim cover or a hubcap.

Fig. 6 is an elevation of the rear of the device according to the preceding Figures 4 and 5.

The indicating device 1 for indicating the state of pressure of a tyre 2 is fitted to the rim 3 of the wheel in an exactly coaxial position. It is connected stably by means of a connecting tube 4 to the tyre 2 inflation valve 5.

With reference to Figs 2 and 3, the device consists of an openable box 6 provided with holes 106 for fixing it to the rim 3 of the tyre 2. The fixing

holes 106 are advantageously provided in external extensions of the box 6. The box 6 houses a pressure measuring device 7 to which the connecting tube 4 is connected and a transducer/transmitter 8 of which only the printed circuit is shown in Fig. 3. The transducer/transmitter 8 converts the measured signals generated by the pressure gauge 7 into electrical signals and transmits them to an electronic unit installed in the driver's compartment (not shown). Supported freely rotatably in bushes or bearings 9, 10 in the box 6 is a coaxial spindle 11 which extends from one side to the other of the box 6. Mounted coaxially on the spindle 11, and freely rotatable about it, is a rotor, indicated as a whole by the reference 12, which forms part of a rotating electrical current generator intended to produce the electrical energy for the recharging of rechargeable batteries by which the transducer/transmitter 8 is powered. The rotor 12 is fixed stably to the side of the box 6 secured to the wheel rim 3. When mounted on the wheel, the spindle 11 and the rotor 12 are arranged coaxially with its axis of rotation and the box 6 with the rotor 12 are coupled in rotation to the wheel about the spindle 11. Mounted on the rotatable spindle 11, and rotatable with it, is a stator 13. The stator is arranged directly alongside the rotor 12. Fixed integrally to the furthest face of the stator 13 from the rotor 12 is a radial extension 14 forming a counterweight giving the stator 13 an inertial rest state sufficient for it to remain motionless, reliably overcoming the forces of magnetic attraction acting between the rotor 12 and the stator 13. The radical extension 14 is formed by a plate in the form of a sector of a circle coaxial with the axis of the stator 13 and spindle 11 and presenting an angular width of between 30° and 90°. The plate has a concentric arcuate slot 23 at a greater radial distance than the outer peripheral wall of the electrical generator. Superimposed on the radial extension 14 on its side furthest from the stator 13 is an arm 14' which is supported freely rotatably on the spindle 11. The arm 14' possesses a pin 114' projecting axially towards the radial extension 14 and engaging slidably within the arcuate slot 23 in said extension 14. The radial length of the arm 14' is greater than that of the radial extension 14 and less than that of the box 6. Said arm 14' carries a weight 15 at its free end. The weight 15 projects axially towards the radial extension 14 and lies externally over the peripheral edge of the radial extension 14 at a certain distance from this edge. It may be made in the form of an axial fin which is suitably arcuate concentrically with the spindle 11 both on its radially outward side and on its radially inward side. The component formed by the weight 15 and the arm 14' weigh approximately the same as the radial extension 14 and form a second counterweight which is movable relative to the first in both directions of rotation through a small angle. By this means the second counterweight efficiently damps the swinging movement of the first counterweight, that is of the radial extension 14, which movement is particularly present during acceleration and deceleration of the rotary motion of the wheel and may cause the stator 13 and extension 14 also to rotate in the same direction as the wheel, causing either a reduction in the amount of energy produced or an interruption in the production of energy.

With particular reference to Fig. 3, the rotor 12 is formed by a generally cylindrical ferromagnetic core 16, especially an iron core, which advantageously also forms the housing of the bush 9 in which the spindle 11 is supported. Fixed round the ferromagnetic core 16, without the possibility of relative rotation and with the aid of an insulating coil 17, is an annular winding 18 in which the electrical current is induced. The winding 18 is interposed between two ferromagnetic discs 19, 20, of which the disc 19 furthest from the stator 13 carries a peripheral ring of axial extensions 21 pointing towards the stator 30 and equidistant from each other. The extensions 21 embrace the stator 13 around its periphery at a very small distance therefrom. The stator 13 consists of an annular permanent multipolar of magnet a type readily available on the market. It is mounted on a plastic core 22 for non-rotatable fixing to the spindle 11. The multipolar magnet has many equidistant peripheral poles with alternating polarities. Advantageously, the number of magnetic poles of the multipolar magnet corresponds to the number of extensions 21 of the rotor. The electrical current is induced in the winding 18 of the rotor 12 by exploiting the rotational energy of the wheel and the force of gravity by which the stator 13 is kept more or less motionless, by virtue of the changes in the magnetic flux to which the winding 18 is subject during the relative rotation of the annular multipolar magnet of the stator 13 and of the ferromagnetic ring of extensions 21 of the rotor 12.

A further feature of the invention is that the current generator is generally cylindrical in form, while the box 6 comprises a housing chamber that is also cylindrical in form and coaxial with the generator, its radius being slightly greater than that of the component formed by the arm 14' and the weight 15. The dimensions of the whole assembly are such that the radial extension 14 and the component formed by the arm 14' and the weight 15 do not interfere with the measuring means 7 and with the transducer/transmitter 8, these being housed in the remaining peripheral annular part of the cylindrical chamber.

The device therefore has not only the advantages described above but also great structural simplicity and very small space requirements. Consequently costs are very low and the device operates both reliably and efficiently, avoiding the use of moving contacts or exhaustible sources of electrical power.

Figs 4 to 6 show an alternative embodiment of the device 1 according to the invention, in which the device comprises not only the box 6' but also a covering part for the outward side of the rim, with any desired radial extension, for example a rim cover 30 or a hubcap. The box 6' is fixable by snap-on means coaxially with the wheel on the outward side of the rim cover 30 or, alternatively, partly or wholly recessed into it. The rim cover 30 may be fixed to the wheel by any means.

The fixing means of the box 6' are a coaxial peripheral ring of axial fixing lugs 206', which in the example shown comprises eight fixing lugs 206' arranged in pairs, the pairs being set out in the form of a cross. The free ends of the fixing lugs 206' project towards the rear side of the box 6' and yield elastically radially towards the middle. At its free end, each possesses a terminal catching tooth 306' which projects from the radially outward side of the end and whose radially outward side tapers towards the free end. The lugs 206' are preferably arcuate to correspond to the radius of the ring formed by them and the tooth 306' runs along their full angular width. The fixing lugs 206' are intended to snap into coinciding slots in the rim cover 30.

In the embodiment shown, in the place of the slots, the rim cover 30 has a window whose shape is basically complementary to the shape of the box 6' in plan, or at least of the rear part of this box and which window is coaxial with the wheel when the rim cover 30 is mounted. In this case, as Fig. 5 shows, the teeth 306' engage behind the edge 130 of said window. The lugs 206' are on an external annular flange 606' on the front side of the box 6'. These lugs extend parallel to the peripheral side of the box 6' and are separated from it radially outwardly by a sufficient distance to avoid interference between the lugs 206' and said peripheral side, ensuring that the lugs can bend radially inwards when the box 6' is being fitted to the rim cover 30. The axial length of the lugs 206' is such that they do not project beyond the rear side of the box 6'. The lugs 206' preferably terminate slightly short of said rear side. Consequently, when mounted on the rim cover 30, the box 6' is partly recessed into it and extends partly outwards from the rim cover 30. Its front side is advantageously convex towards the outside and joins smoothly to the peripheral flange 606' which tapers substantially against the adjacent part of the rim cover 30.

By way of an improvement, to make it possible to fix the box 6' firmly also in the axial direction towards the wheel, at a distance corresponding approximately to the thickness of the edge 130 of the window in the rim cover 30, each lug 206' comprises an outward radial step opposite to the tooth 306'. In this way said edge 130 snap fastens between the tooth 306' and the step 406', preventing any axial translation in either direction of the box 6.

Advantageously, as shown in Fig. 5, the tooth 306' and the opposite step 406' are formed in the lugs 206' by means of a groove 506' cut into the radially outward side of these lugs, the width of this groove 506' corresponding approximately to the thickness of the edge 130 of the window.

Clearly, the invention is not limited to the embodiments described above and illustrated but may be altered and modified in many ways, particularly in structural terms, without departing from the underlying concept described above and claimed below.

Claims

1. Indicating device, especially for indicating the state of pressure of a tyre, of the type that can be fixed to a wheel and comprises means (7) for measuring the pressure of the tyre (2); a transducer/transmitter (8) which converts the measured magnitude of the pressure into an electrical signal and transmits said signal to an electronic unit; and a source of electrical power (12, 13) for the transducer/transmitter (8), characterised in that the electrical power source consists of an inductive current generator formed by a rotor (12) which is fixed coaxially to the wheel so as to rotate as one piece therewith, and by a coaxial stator (13) which is freely rotatable with respect to the rotor (12) and to which there is attached at least one counterweight (14) capable of keeping the stator (13) essentially motionless with respect to the rotor (12) and of overcoming the forces of magnetic attraction between the stator (13) and the rotor (12) as the rotor rotates with the wheel.

2. Device according to Claim 1, characterised in that the counterweight (14) is dynamically connected (23, 114') to damping means (14', 15) which damp any swinging movements of the counterweight, that is to say means for dissipating the kinetic energy of swinging.

3. Device according to Claim 1 or 2, characterised in that the electrical current generator comprises a winding (18) in which the elec-

trical supply current is induced, which is part of the rotor (12) and is fixed to the wheel, especially coaxially and in such a way as to describe no relative movement with respect to the wheel, and a permanent, especially a multipolar, magnetic part formed by the stator (13).

4. Device according to Claim 3, characterised in that the stator (13) and the rotor (12) are arranged coaxially alongside each other.

5. Device according to one or more of the preceding claims, characterised in that the multipolar magnetic part of the stator (13) possesses around its periphery a series of equidistant magnetic poles with alternating polarities.

6. Device according to Claim 5, characterised in that the rotor (12) is provided with a ferromagnetic part (16, 19) which supports a ring of equidistant axial extensions (21) pointing towards the stator (13), which extensions (21) embrace the periphery of the stator (13) at a slight distance from it.

7. Device according to Claim 6, characterised in that the ring of axial extensions (21) possesses a number of axial extensions (21) corresponding to the number of poles of the permanent multipolar magnetic part of the stator (13).

8. Device according to Claim 6 or 7, characterised in that the ferromagnetic part (16, 19) of the rotor (12) forms a box in which the winding (18) is housed.

9. Device according to Claim 8, characterised in that the ferromagnetic part of the rotor (12) comprises a cylindrical core (16) for example an iron core, which is arranged coaxially with the axis of rotation of the wheel (2) and on which there is fixed peripherally a coil (17) in such a way as to form an annular winding (18), while the coil (17) is interposed between two coaxial discs (19, 20), which discs are fixed to the corresponding head of said core (16) and are likewise of a ferromagnetic material, the disc (19) being preferably attached to the side of the rotor (12) furthest from the stator (13) provided with a peripheral ring of axial extensions which point towards the stator (13) and embrace both the further disc (20) and the stator (13) itself, while the stator (13) consists of a coaxial annular multipolar magnet.

10. Device according to Claim 9, characterised in that the rotor (12) is fixed without the possibility of rotation relative to the front wall of the box 6 which is fixed without the possibility of rotation relative to the rim (3) of the wheel, while the stator (13) is fixed on a coaxial spindle (11) in such a way that it can rotate with this spindle (11) and said spindle (11) is supported at its ends rotatably relative to the rotor (12) in bearings (9, 10), one in the core (16) of the rotor (12) and the other in the external front wall of the box (6).

11. Device according to one or more of the preceding claims, characterised in that the counterweight (14) is formed by a radial extension of the stator (13), this extension being provided on the side furthest from the rotor (12) and is fixed to the stator (13) in such a way that it cannot rotate relative thereto.

12. Device according to Claim 11, characterised in that the counterweight (14) is formed by a plate in the form of a sector of a circle concentric with the stator (13), with an angular width of between 30° and 90° and with a radial extension greater than the radius of the generator (12, 13).

13. Device according to one or more of the preceding claims, characterised in that the damping means which damp the swinging movement of the counterweight (14) are formed by a second counterweight (14', 15) which is located axially alongside the first counterweight (14) and is supported eccentrically with respect to the axis of the stator (13) and freely rotatably with respect to it, while means (114', 23) are provided for the dynamic coupling of the first counterweight (14) to the second counterweight (14', 15) which permit a relative angular displacement in both directions and of a limited amplitude between said two counterweights (14, 14', 15).

14. Device according to Claim 13, characterised in that the second counterweight is formed by an arm (14') whose radial length is greater than that of the first counterweight (14) and which is supported at one end by the spindle (11) in such a way that it can rotate freely with respect to it, while its free end carries a weight (15), the arm (14') being provided with a cursor (114') projecting axially towards the first counterweight (14) and engaging slidably in an arcuate guide (23) concentric with the first counterweight (14) and provided with limit stops at its extremities.

15. Device according to Claim 14, characterised in that the weight (15) of the second counterweight is formed by a radial fin projecting axially towards the rotor (12) and lying peripherally over the outward edge of the first counterweight (14), the radially inner and outer walls of the counterweight being concentrically arcuate with respect to the axis of said first counterweight (14).

16. Device according to Claim 14, characterised in that the guide (23) of the first counterweight (14) is formed by an arcuate slot formed therein, while the cursor (114') of the second counterweight (14', 15) is formed by an axial pin projecting from the arm (14').

17. Device according to one or more of the preceding claims, characterised in that the first and second counterweights (14, 14', 15) are approximately equal in weight to each other.

18. Device according to one or more of the preceding claims, characterised in that the box (6) comprises a cylindrical housing having the same axis as the generator (12, 13), with a slightly greater radius than the radius of the second counterweight (14', 15), the dimensions of the whole assembly being such as to form an annular housing chamber for the pressure measuring means (7) and for the transducer/transformer (8), while the chamber possesses external extensions for the means by which it is fixed to the wheel.

19. Device according to one or more of the preceding claims, characterised in that the current generator (12, 13) may directly supply the transducer/transmitter (8) which is provided with suitable transformer circuits for the generated current or may be connected to rechargeable batteries used to power the transducer/transmitter (8).

20. Device according to one or more of the preceding claims, characterised in that it comprises a part (30) which at least partly covers the outward side of the rim, for example a so-called rim cover or hubcap, that can be fixed to the outward side of said rim and a box (6') in which the device is housed, the generator (12, 13) being housed coaxially inside the box (6'), the box (6') and the rim cover (30) possessing complementary means for fixing the box (6') in a coaxial position to the wheel.

21. Device according to Claim 20, characterised in that the fixing means (206', 306', 406'; 130) are of the snap-on type.

22. Device according to either of Claims 20 and 21, characterised in that the box (6') may be fixed to the outward side of the rim cover (30).

23. Device according to either of Claims 20 and 21, characterised in that the box (6') is partly or completely recessed into the rim cover (30).

24. Device according to one or more of the preceding Claims 20 to 23, characterised in that the means by which the box (6') is fixed consist of a ring of peripheral fixing lugs (206'), comprising at least two diametrically opposed fixing lugs (206') pointing axially with their free ends projecting towards the rim cover (30), the fixing lugs (206') being elastically radially flexible and having teeth (306') at their free ends.

25. Device according to Claims 22 and 24, characterised in that the rim cover (30) is provided with slots in which the fixing lugs (206') of the box (6') can engage, the teeth (306') of these lugs being intended to engage behind the edge (130) of said slots when the box (6') has been mounted.

26. Device according to Claims 23 and 24, characterised in that the rim cover (30) comprises a window in which to receive the box (6, 6') that is arranged coaxially with the wheel when the rim cover (30) is mounted and behind whose edge (130) the teeth (306') of the ring of fixing lugs (206') of the box (6') engage, the dimensions of the window generally corresponding to or being slightly less than those of the ring of fixing lugs (206'), and said ring of fixing lugs (206') being provided coaxially around the box (6') at such a radial distance from the peripheral part of the box (6') as to allow the fixing lugs (206') to bend elastically radially inwards, while the teeth (306') of the fixing lugs (206') point radially outwards.

27. Device according to Claim 26, characterised in that the ring of lugs (206') is on a peripheral annular flange (606') on the outward front side of the box (6').

28. Device according to one or more of the preceding Claims 20 to 27, characterised in that eight fixing lugs (206') are arranged in pairs, which pairs are set out in the form of a cross.

29. Device according to one or more of the preceding Claims 20 to 28, characterised in that the lugs (206') possess an outward radial step

(406') opposite to the tooth (306') at a distance from the tooth which approximately corresponds to the thickness (130) of the edge of the coinciding apertures in the rim cover (30).

30. Device according to Claim 29, characterised in that the tooth (306') and the step (406') are formed by a peripheral groove (606') in the outward side thereof.

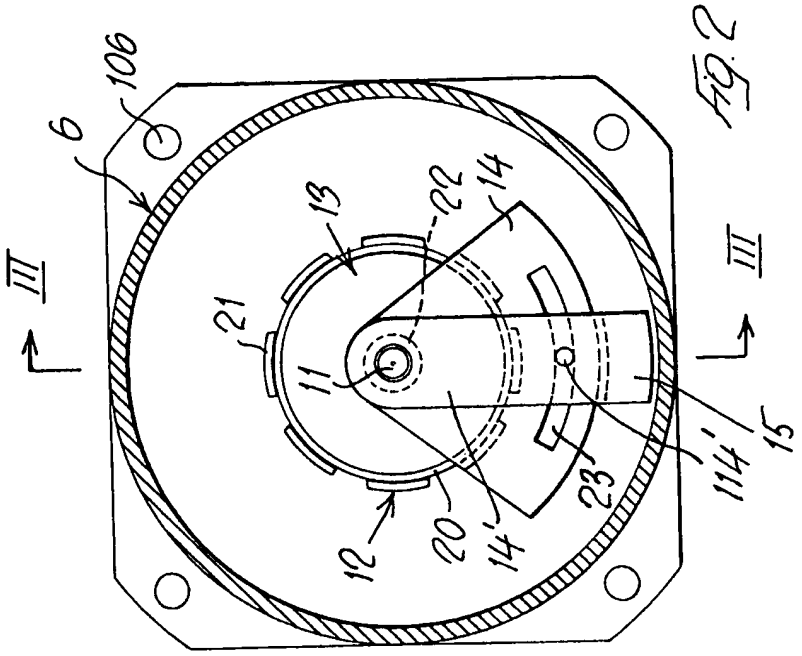

Fig.2

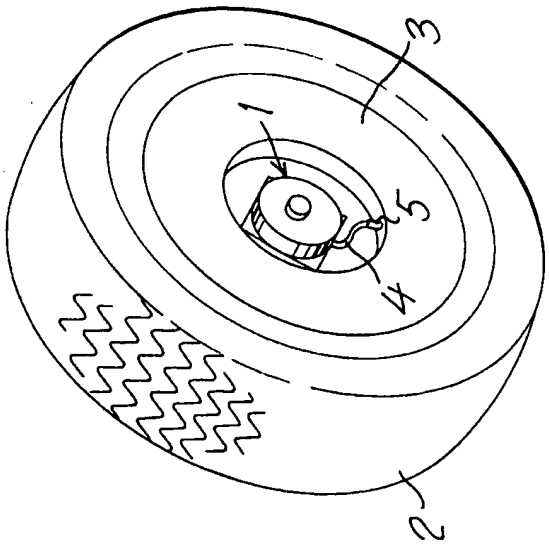

Fig.1

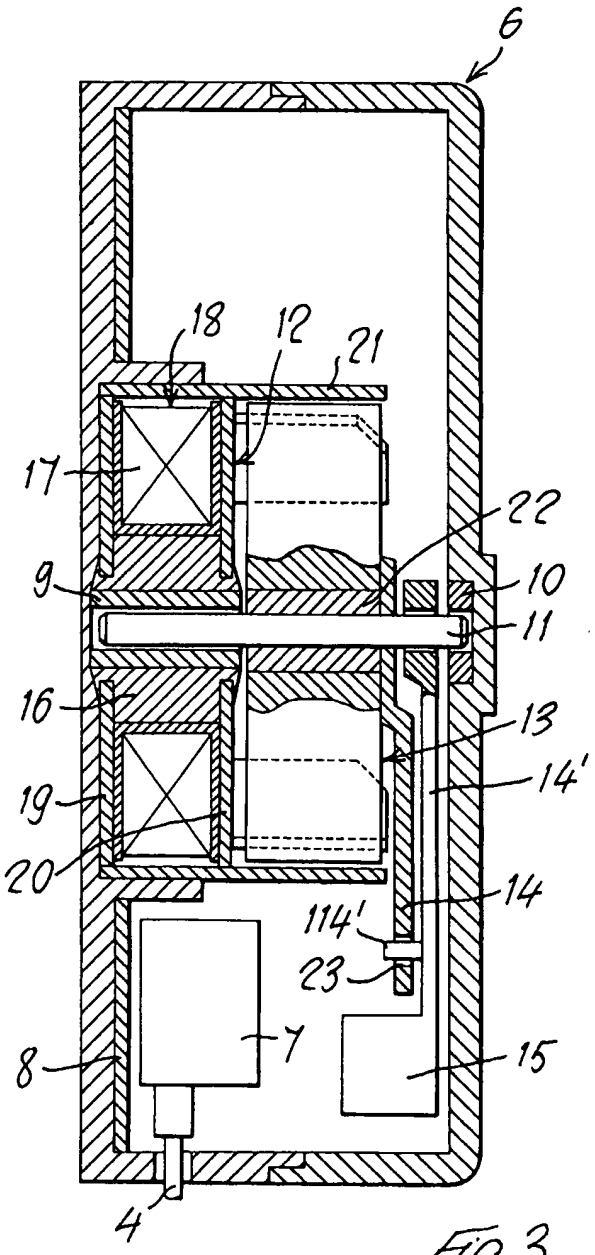

Fig. 3

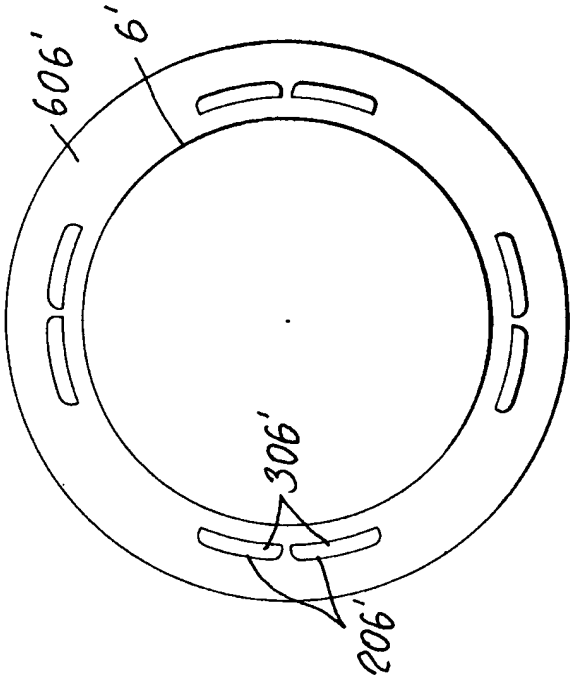

Fig. 6

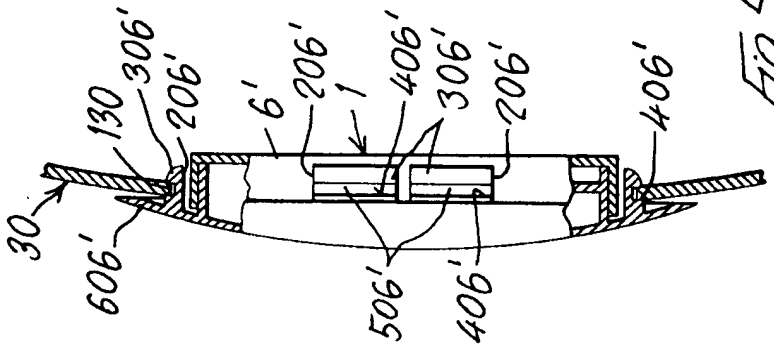

Fig. 5

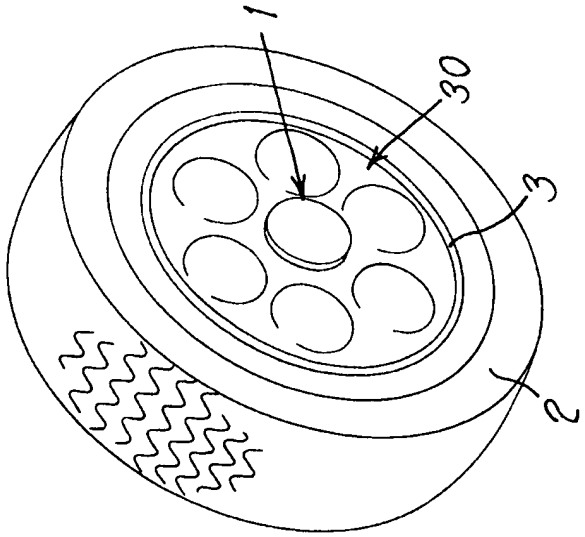

Fig. 4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 93 10 4631

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	US-A-4 075 603 (SNYDER) * column 4, line 32 - column 7, line 54; figures *	1,3,5-8, 11,12,18	B60C23/04
Y		2,4, 20-24	
Y	US-A-3 751 697 (MORLEY) * the whole document *	4	
P,Y	DE-A-4 036 362 (BINDER) * column 3, line 55 - column 4, line 61; figures 4,5 *	2,20-24	
X	US-A-4 229 728 (TREMBA) * column 4, line 10 - column 5, line 41; figures 1-3 *	1,3,4	
X	US-A-4 536 668 (BOYER) * column 8, line 18 - line 43; figure 11 *	1,3-5	
A	US-A-2 211 935 (PARKER) * column 2, line 9 - line 26; figure 1 *	20-24	TECHNICAL FIELDS SEARCHED (Int. Cl.5) B60C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21 JUNE 1993	HAGEMAN M.

CATEGORY OF CITED DOCUMENTS

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